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Guo et al.

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(54) **ELECTRICAL CONNECTOR HAVING POWER TERMINALS IN AN UPPER ROW IN CONTACT WITH THOSE IN A LOWER ROW**

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(51) **Int. Cl.**

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H01R 12/70	(2011.01)
H01R 12/58	(2011.01)

(52) **U.S. Cl.**

CPC ***H01R 13/6585*** (2013.01); ***H01R 12/585*** (2013.01); ***H01R 12/7005*** (2013.01)

(58) **Field of Classification Search**

CPC H01R 9/091; H01R 12/00; H01R 12/57; H01R 12/585; H01R 12/70; H01R 12/7005; H01R 13/6585; H01R 23/725; H01R 23/7073

USPC 439/78

See application file for complete search history.

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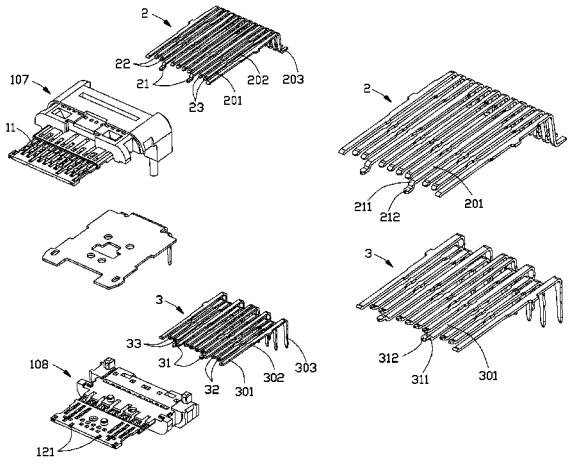
(57) **ABSTRACT**

An electrical connector includes a terminal module and a plurality of terminals retained in the terminal module. The plurality of terminals are divided into an upper row and a lower row. Each of the terminals has a contacting portion contacting with a complementary connector. Each row of the terminals has a power terminal and a differential pair. The contacting portion of the power terminal in the upper row and the corresponding contacting portion of the power terminal in the lower row mechanically contact with each other to form parallel electrical paths.

17 Claims, 8 Drawing Sheets



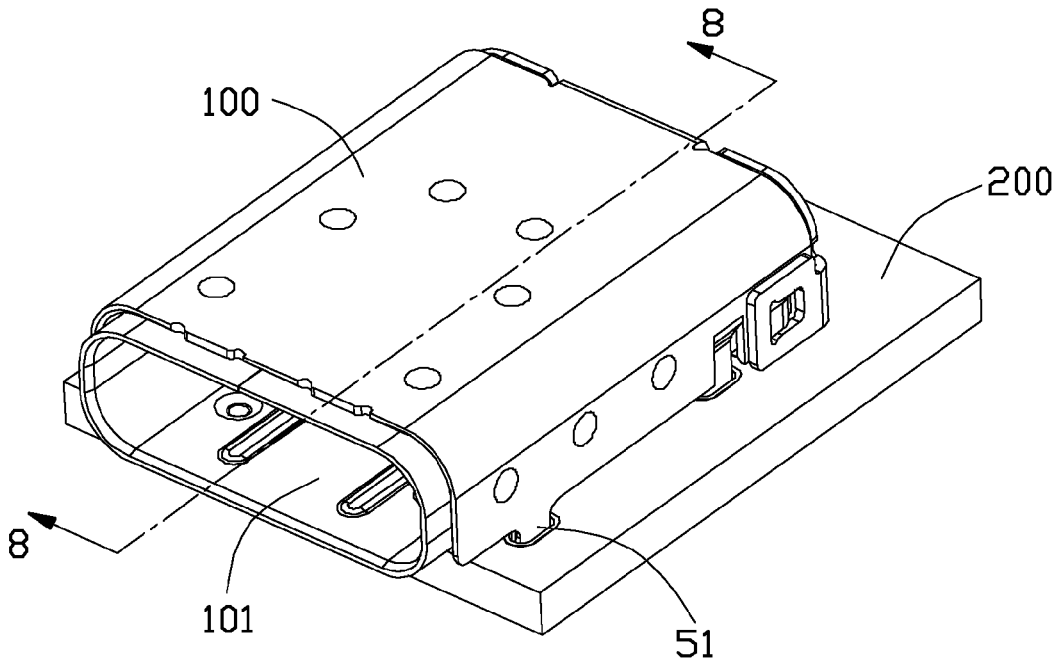


FIG. 1

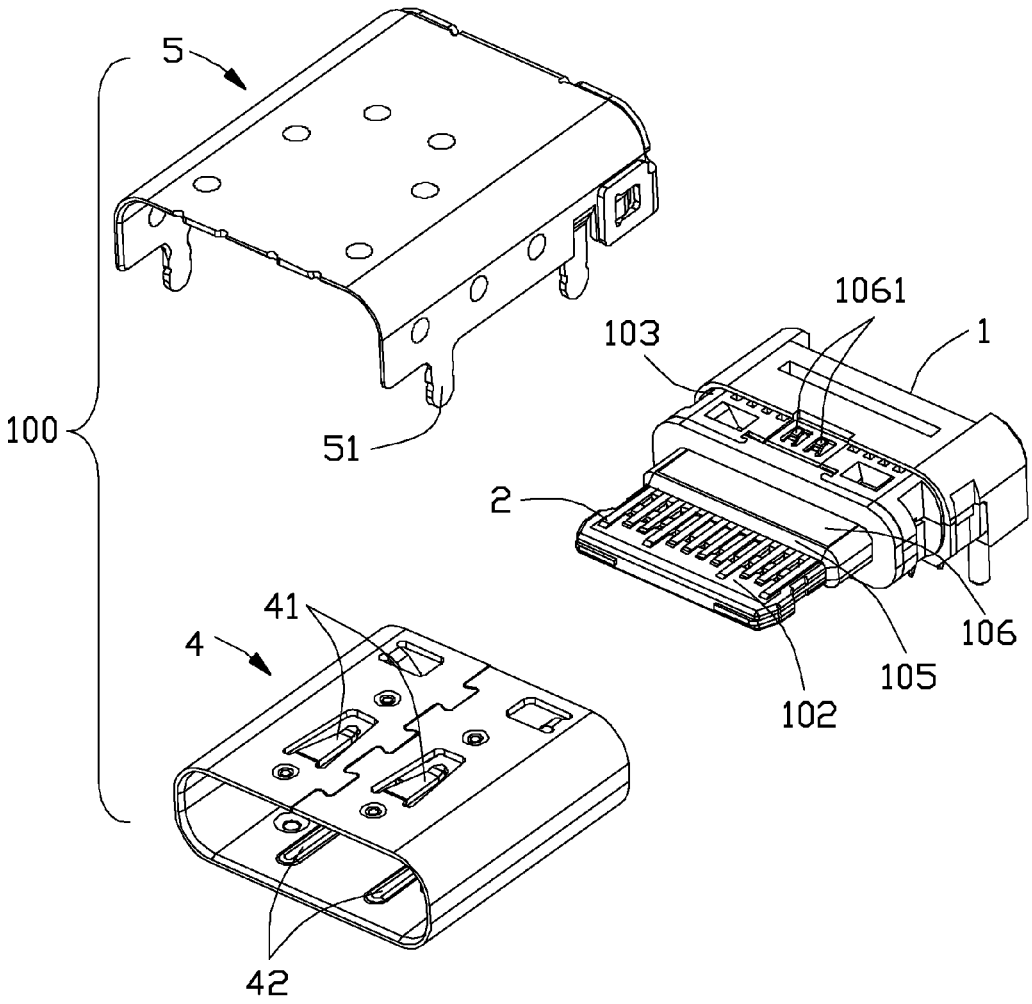


FIG. 2

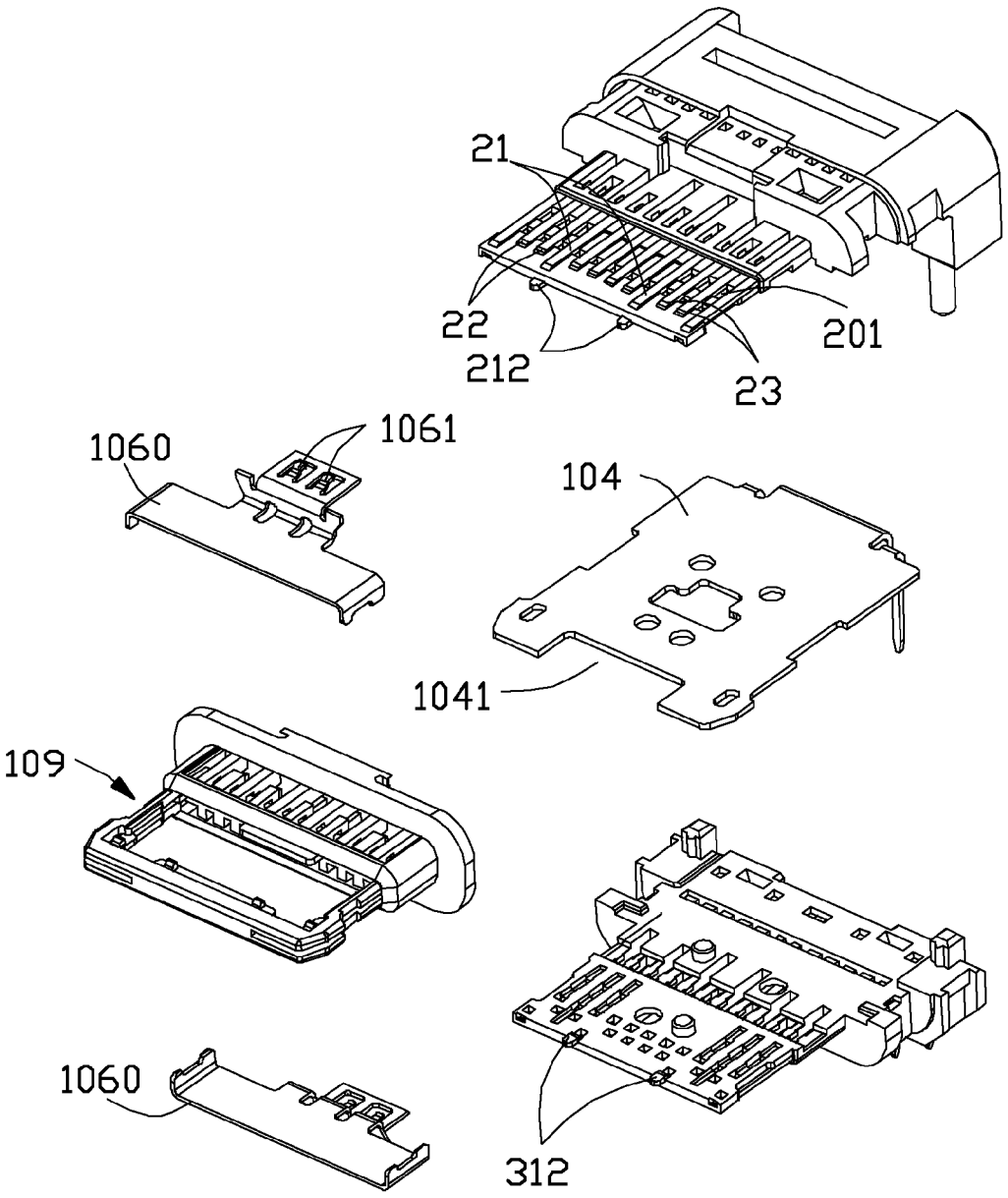


FIG. 3

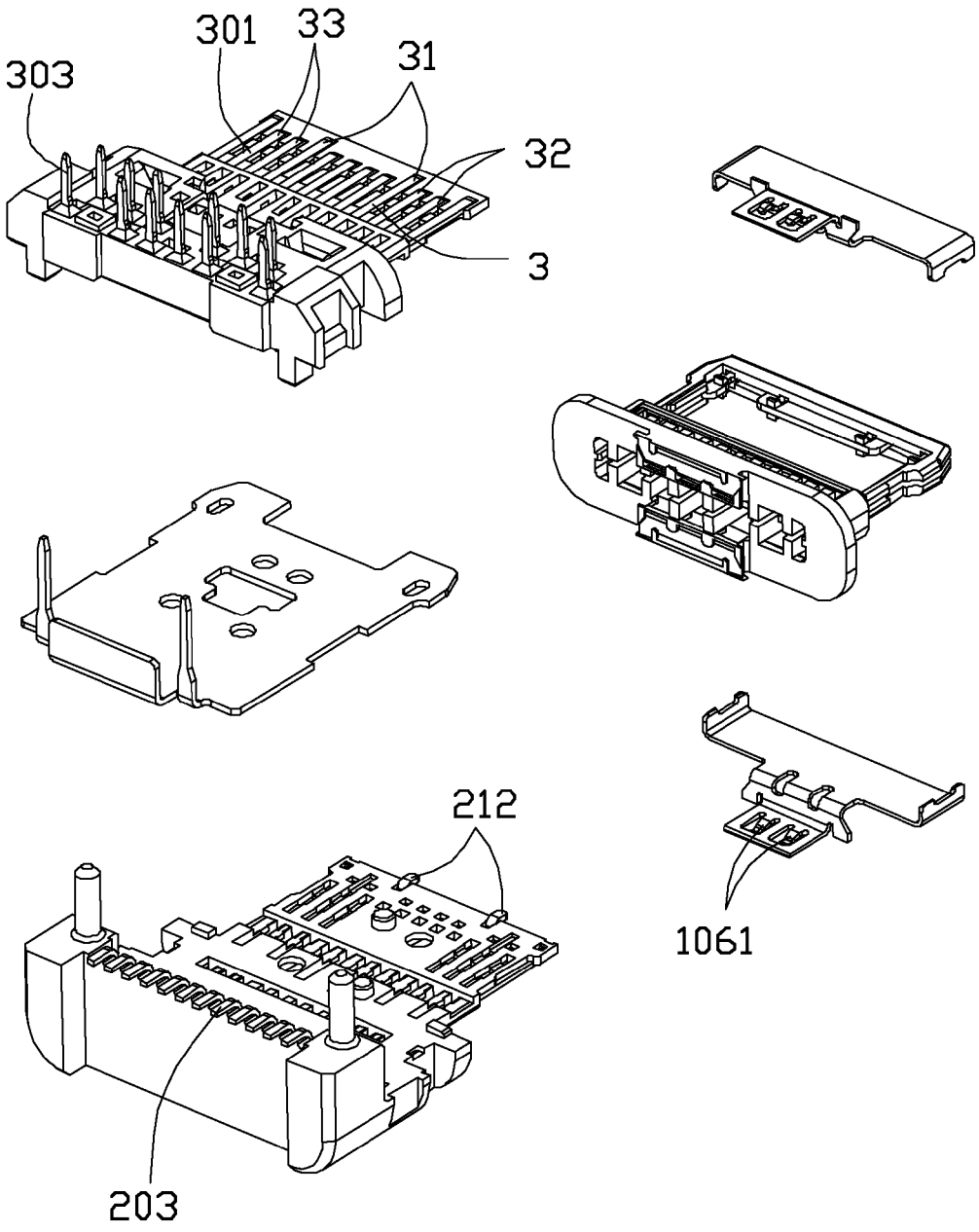


FIG. 4

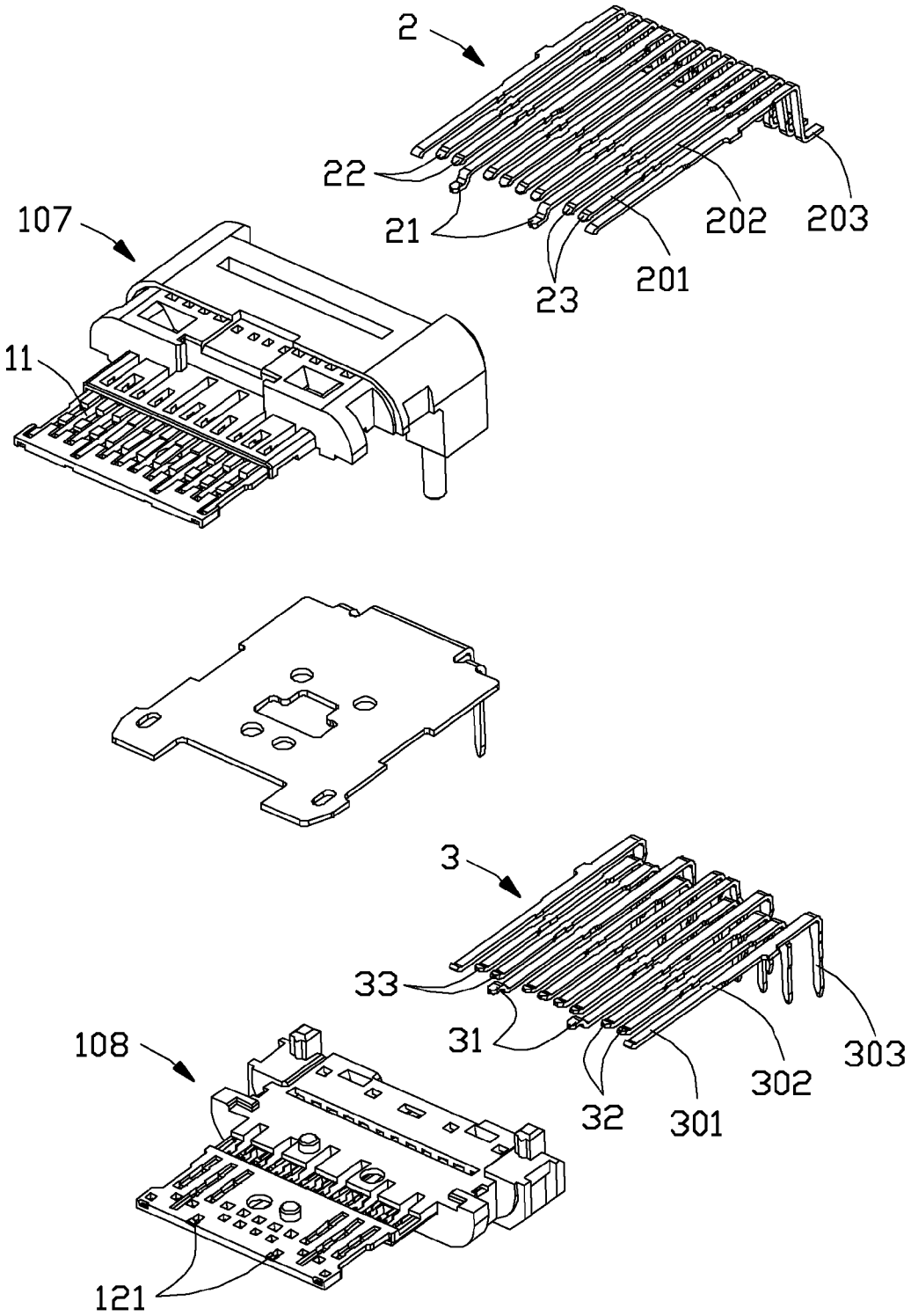


FIG. 5

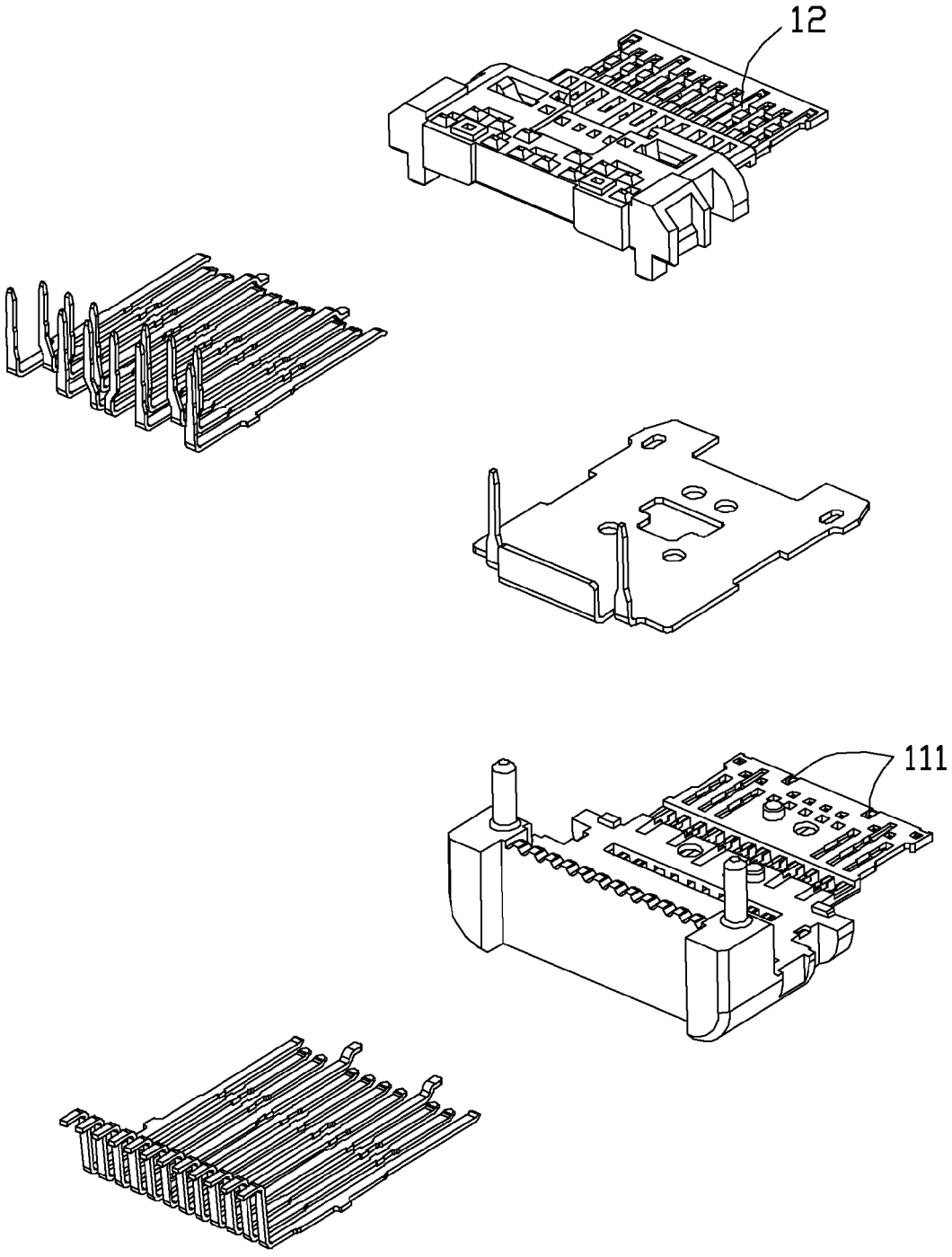


FIG. 6

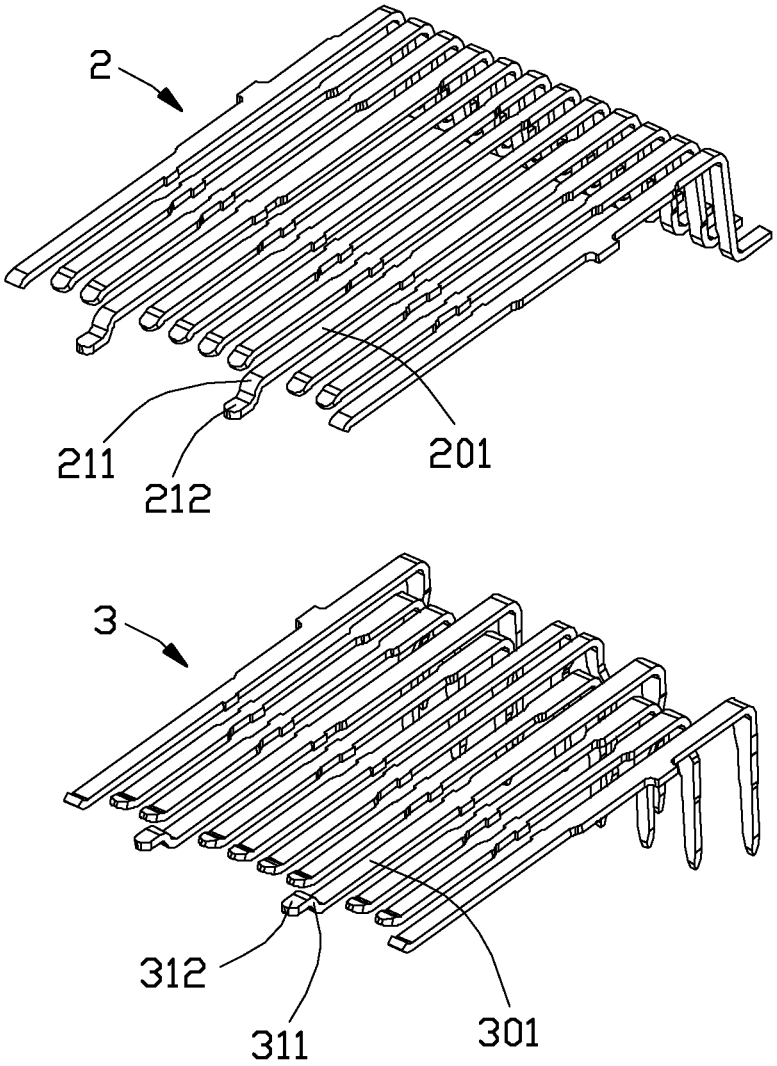


FIG. 7

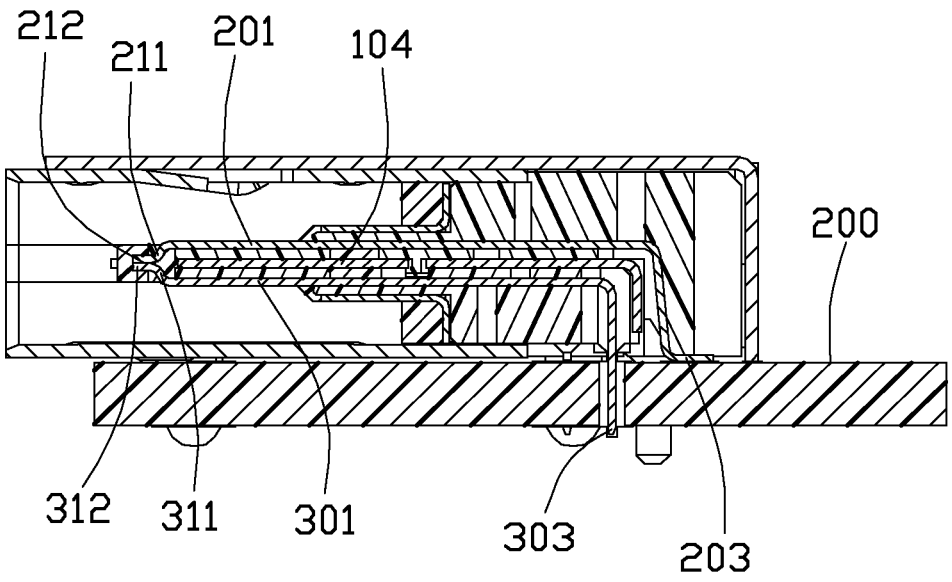


FIG. 8

ELECTRICAL CONNECTOR HAVING POWER TERMINALS IN AN UPPER ROW IN CONTACT WITH THOSE IN A LOWER ROW

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an electrical connector, and particularly to an electrical connector having power terminals secured therein. The application relates to the copending application having the same filing date, the same applicant and the common inventors with the instant application, and titled "ELECTRICAL CONNECTOR WITH UPPER AND LOWER GROUNDING TERMINALS CONNECTED WITH EACH OTHER".

2. Description of Related Art

USB standards association published a new type of connector called USB Type-C connector in Aug. 11, 2014. The USB Type-C connector is improved on the basis of USB 2.0 and USB 3.0. The mating cavity of the USB Type C receptacle is symmetric so as to provide an interface into which a USB Type C plug may insert in two opposite orientation. The USB Type-C connector may meet the requirement of 10 Gbit/s transmission rate same as USB 3.1. According to specification published by the association, the USB Type-C receptacle connector has an insulative housing and two opposite rows of upper terminals and lower terminals disposed in the insulative housing. The upper terminals have at least a power terminal, differential pairs including TX and RX Pairs. The upper terminals and the lower terminals are separated from each other without any contacting therebetween. In the process of development, we find that serious influence will be caused between the tow signal terminals in each differential pair during signal transmission.

In view of the above, an improved electrical connector is desired to overcome the problems mentioned above.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide an electrical connector, the resonance point of the frequency domain of the electrical connector and the interference between the signal terminals in each differential pair are improved.

According to one aspect of the present disclosure, an electrical connector mating with a complementary connector comprises a terminal module and a plurality of terminals retained in the terminal module. The plurality of terminals are divided into an upper row and a lower row. Each of the terminals has a contacting portion contacting with a complementary connector. Each row of the terminals has a power terminal and a differential pair. The contacting portion of the power terminal in the upper row and the corresponding contacting portion of the power terminal in the lower row mechanically contact with each other to form parallel electrical paths.

Other objects, advantages and novel features of the disclosure will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is perspective view of an electrical connector mounted on a printed circuit board;

FIG. **2** is a partly exploded perspective view of the electrical connector shown in FIG. **1**;

FIG. **3** is an exploded perspective view of a terminal module shown in FIG. **2**;

FIG. **4** is another perspective view of which shown in FIG. **3**;

FIG. **5** is a part exploded perspective view of the electrical connector shown in FIG. **1**;

FIG. **6** is another perspective view of which shown in FIG. **5**;

FIG. **7** is a perspective view of upper terminals and lower terminals of the electrical connector shown in FIG. **1**; and

FIG. **8** is a sectional perspective view of the electrical connector along line **8-8** shown in FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made to the drawings to describe a preferred embodiment of the present disclosure in detail.

Referring to FIGS. **1-2** and **4**, the present invention provided with an electrical connector **100** mounted on a printed circuit board **200**. The electrical connector **100** may mate with a complementary connector (not labeled). The electrical connector **100** has a terminal module **1**, a row of upper terminals **2** and a row of lower terminals **3** retained in the terminal module **1**, a metallic shell **4** surrounding the terminal module **1**, and a metallic cover **5** retained on the metallic shell **4**.

Referring to FIGS. **3-6**, the upper terminals **2** each has a contacting portion **201** electrically connecting with a complementary connector, a middle portion **202** and a soldering leg **203** (shown in FIG. **5**). The lower terminals **3** each has a contacting portion **301** electrically connecting with the complementary connector, a middle portion **302** and a soldering leg **303** (shown in FIG. **5**). The upper terminals **2** have at least a power terminal **21**, a differential pair **22** used for transmitting date at high speed, and a differential pair **23** used for receiving date at high speed. The differential pairs **22**, **23** are adjacent to the power terminal **21**. The lower terminals **3** have at least a power terminal **31**, a differential pair **32** used for transmitting date at high speed, and a differential pair **33** used for receiving date at high speed. The differential pairs **32**, **33** are adjacent to the power terminal **31**. The upper terminals **2** have at least a grounding terminal (not labeled), the lower terminals **3** also have at least a grounding terminal (not labeled). The power terminal **21** in the upper row and the power terminal **31** in the lower row mechanically and electrically connect with each other so as to form parallel electrical paths. In the present embodiment, the upper terminals **2** have two power terminals **21** apart from each other, the differential pair **22** used for transmitting date at high speed is adjacent to one power terminal **21** and the differential pair **23** used for receiving date at high speed is adjacent to another power terminal **21**. The lower terminals **3** also have two power terminals **31** apart from each other, the differential pair **32** used for transmitting date at high speed is adjacent to one power terminal **31** and the differential pair **33** used for receiving date at high speed is adjacent to another power terminal **31**. More specifically, the soldering portions **203**, **303** of the power terminals **21**, **31** are retained on the printed circuit board **200** and electrically connect with power points (not labeled) of the printed circuit board **200**. The power soldering points on the printed circuit board **200** are normally regarded as the power points. Free ends of the contacting portions **201**, **301** of the corresponding power terminals **21**, **31** of the upper and lower terminals **2**, **3** mechanically contact with each other. Combined with FIG. **7**, front free

end of the contacting portion **201** of the power terminal **21** of the upper terminals **2** initially bends downwardly at a certain angle to form a first bending portion **211**, and then forwardly and horizontally extends to form a first extending portion **212**. Corresponding free end of the contacting portion **301** of the power terminal **31** of the lower terminals **3** initially bends upwardly at a certain angle to form a second bending portion **311**, and then forwardly and horizontally extends to form a second extending portion **312**. Combined with FIG. **8**, the first extending portion **212** and the second extending portion **312** contact with each other.

Referring to FIGS. **5-6**, the terminal module **1** has a plurality of upper slots **11** and lower slots **12**. The contacting portions **201** are received in the upper slots **11**, and the contacting portions **301** are received in the lower slots **12**. The slot **11** has a hole **111** recessed downwardly from an inner surface corresponding to the free end of the contacting portion **201** of the power terminal **21**, the slot **12** has a hole **121** recessed upwardly from an inner surface corresponding to the free end of the contacting portion **301** of the power terminal **31**. The holes **111**, **121** are communicating with each other. Combined with FIG. **8**, the first bending portion **211** and the second bending portion **311** are respectively inserted into the corresponding holes **111**, **121** so as to make the first extending portion **212** and the second extending portion **312** contacting with each other.

Referring to FIGS. **2-4**, as a preferred embodiment of the present invention, the terminal module **1** has a base portion **103** located at a rear side thereof and a mating portion **102** at a front side thereof. The mating portion **102** has two opposite mating faces. The slots **11**, **12** respectively disposed at two mating faces aforementioned. The electrical connector **100** has a shielding plate **104** retained in the mating portion **102** and being sandwiched between the two slots **11**, **12**. The shielding plate **104** has an notch **1041** corresponding to the holes **111**, **121** so as to form a room in which the first extending portion **212** and the second extending portion **312** dispose and mechanically contact with each other. The mating portion **102** has a stepping portion **105** adjacent to the base portion **103**. The base portion **103** and the stepping portion **105** are made from plastic material. The middle portions **202**, **302** of the terminals **2**, **3** are embedded in the stepping portion **105**, the soldering portions **203**, **303** extends out of the base portion **103** and are soldered on the printed circuit board **200**. The electrical connector **100** has two grounding members **106** disposed at two opposite faces of the stepping portion **105**. The two grounding members **106** each has a grounding portion **1060** attached on a surface of the base portion **103**. The grounding portion **1060** has an elastic contacting plate **1061** elastically abutting on the metallic shell **4**. Referring to FIGS. **3-6**, the terminal module **1** has an upper insulator **107**, a lower insulator **108** and an over-molding portion **109** corresponding with the upper insulator **107** and the lower insulator **108**. The slots **11** are disposed in a front area of the upper insulator **107**, the slots **12** are disposed in a front area of the lower insulator **108**. The shielding plate **104** is sandwiched between the upper insulator **107** and the lower insulator **108**. The row of the upper terminals **2** are embedded in the upper insulator **107**, the row of the lower terminals **3** are embedded in the lower insulator **108**. The stepping portion **105** formed by the upper insulator **107** and the lower insulator **108** is surrounded by the grounding members **106**. Notably, the two grounding members **106** may be formed as one unite in other embodiments.

Referring to FIGS. **1-2**, the metallic shell **4** is retained on an outer surface of the base portion **103** and surrounds the mating portion **102** and the stepping portion **105** to form a mating cavity **101**. The metallic shell **4** has an upper wall having two pressing portions **41** extending into the mating cavity **101** from a front area of the upper wall. The metallic shell **4** has a lower wall having two ribs **42** protruding into the mating cavity **101**. The rib **42** each extends along the mating direction. The metallic cover **5** is retained on the metallic shell **4** by laser welding technology. The metallic cover **5** has a plurality of mounting legs **51** extending downwardly at two sides thereof to be soldered on the printed circuit board **200**.

The first bending portion **211** of the power terminal **21** is inserted into the hole **111**, the second bending portion **311** of the power terminal **31** is inserted into the hole **121**, the hole **111** and the hole **121** are aligned with each other and communicate with each other to form a room in which the first extending portion **212** and the second extending portion **312** dispose and mechanically contact with each other, thereby the corresponding power terminals **21**, **31** are parallel electrical paths. Due to the improved structure, the resonance point of the frequency domain of the electrical connector and the interference between signal terminals in each differential pair are improved. The electrical connector **100** of the present invention may meet the provision of the USB Type-C specification.

In other embodiments, the shape and the size of the holes **111**, **121** may be changed adaptively. The notch **1041** may be closed in the front.

While preferred embodiment in accordance with the present disclosure has been shown and described, equivalent modifications and changes known to persons skilled in the art according to the spirit of the present disclosure are considered within the scope of the present disclosure as defined in the appended claims.

What is claimed is:

1. An electrical connector for mating with a complementary connector, comprising:

a terminal module;

a plurality of terminals retained in the terminal module, the plurality of terminals being divided into an upper row and a lower row, each of the terminals having a contacting portion contacting with a complementary connector, each row of the terminals having a power terminal and a differential pair;

wherein the contacting portion of the power terminal in the upper row and the corresponding contacting portion of the power terminal in the lower row mechanically contact with each other to form parallel electrical paths.

2. The electrical connector as claimed in claim **1**, wherein the electrical connector is fixed on a printed circuit board, front end of the power terminal in each row is regarded as a free end of the contacting portion, rear end of the power terminal is regarded as a soldering leg, the soldering leg of the power terminal is inserted and retained on the printed circuit board and electrically connected with a power point of the printed circuit board, the free ends of the two corresponding power terminals in two rows mechanically contact with each other.

3. The electrical connector as claimed in claim **2**, wherein the free end of the contacting portion of the power terminal in the upper row bends downwardly to form a first bending portion and then forwardly and horizontally extending to form a first extending portion, the free end of the contacting portion of the power terminal in the lower row bends upwardly to form a second bending portion and then forwardly and horizontally extending to form a second extend-

ing portion, the first extending portion and the second extending portion contact with each other.

4. The electrical connector as claimed in claim **3**, wherein the terminal module has a plurality of upper slots and lower slots, the contacting portions are respectively received in the upper slots and lower slots, the upper slot for receiving the power terminal in the upper row has a hole recessed from an inner surface thereof to correspond to the free end of the contacting portion of the power terminal in the upper row, the lower slot for receiving the power terminal in the lower row has a hole recessed from an inner surface to correspond to the free end of the contacting portion of the power terminal in the lower row, the hole in the upper slot and the hole in the lower slot communicate with each other, the first and second extending portions respectively run into corresponding holes to contact with each other.

5. The electrical connector as claimed in claim **4**, wherein the terminal module has a base portion in a rear side and a mating portion in a front side, the mating portion has two opposite surfaces, the upper slots and lower slots are respectively disposed at the two opposite surfaces.

6. The electrical connector as claimed in claim **5**, wherein the electrical connector has a shielding plate disposed in the mating portion, the shielding plate is sandwiched between the upper slots and the lower slots, the shielding plate has a notch corresponding to the holes to form a room in which the first extending portion and the second extending portion dispose and mechanically contact with each other.

7. The electrical connector as claimed in claim **5**, wherein the mating portion has a stepping portion adjacent to the base portion, the electrical connector has a grounding member disposed at two opposite faces of the stepping portion, the terminal has a middle portion embedded in the stepping portion, the soldering leg extending out of the base portion.

8. The electrical connector as claimed in claim **1**, wherein the differential pair is adjacent to the power terminal in each row, and the plurality of terminals comprise a grounding terminal in each row.

9. The electrical connector as claimed in claim **1**, wherein the plurality of terminals are insert molded with the terminal module.

10. The electrical connector as claimed in claim **5**, wherein the electrical connector has a metallic shell retained on an outer surface of the base portion and surrounding the mating portion and the stepping portion to form a mating cavity.

11. An electrical connector comprising:

a terminal module having two opposite mating faces;

an upper row of terminals retained in the terminal module and exposed upon one of the mating faces; and

a lower row of terminals retained in the terminal module and exposed upon the other mating face;

wherein the upper and lower rows of terminals each comprise a power terminal and a differential pair adjacent to the power terminal, and the power terminal in the upper row mechanically contact with the power terminal in the lower row.

12. The electrical connector as claimed in claim **11**, wherein each power terminal defined in upper and lower rows has a contacting portion and a leg portion, the contacting portion of the power terminal in the upper row and the corresponding contacting portion of the power terminal in the lower row mechanically contact with each other.

13. An electrical connector for mounting to a printed circuit board, comprising:

a terminal module including:

a mating tongue defining opposite upper surface and lower surface in a vertical direction;

a plurality of upper contacts each having an upper contacting section exposed on the upper surface, and an upper mounting leg for mounting to the printed circuit board, said upper contacts being categorized with upper power contacts, upper differential pair contacts neighboring the corresponding upper power contact in a transverse direction perpendicular to said vertical direction, and upper grounding contacts; and

a plurality of lower contacts each having a lower contacting section exposed upon the lower surface, and a lower mounting leg for mounting to the printed circuit board, said lower contacts being categorized with lower power contacts, lower differential pair contacts neighboring the corresponding lower power contact in the transverse direction, and lower grounding contacts; wherein

the upper contacting section of one upper power contact is aligned with the lower contacting section of the corresponding one lower power contact in the vertical direction;

at least one of said upper contacting section of said one upper power contact and the lower contacting section of said corresponding one lower power contact, extends, with an extending portion, toward and contacts the other of said upper contacting section of said one upper power contact and the lower contacting section of said corresponding one lower power contact in the vertical direction.

14. The electrical connector as claimed in claim **13**, further including a metallic shielding plate embedded within the mating tongue between the upper surface and the lower surface, wherein said shielding plate forms a notch to receive said extending portion.

15. The electrical connector as claimed in claim **14**, wherein the upper contacts are embedded within an upper insulator, the lower contacts are embedded within a lower insulator to cooperate with the upper insulator to sandwich the shielding plate therebetween in the vertical direction, an over-molding portion covering both said upper insulator and said lower insulator, and said extending portion extends beyond the corresponding one of said upper insulator and said lower insulator while covered by said over-molding portion.

16. The electrical connector as claimed in claim **15**, wherein both said upper contacting section of said one upper power contact and said lower contacting section of said corresponding one lower power contact have the corresponding extending portions, respectively, and encountered with each other in the notch of said shielding plate.

17. The electrical connector as claimed in claim **13**, wherein said extending portion is located around a front end of the corresponding contacting section.

* * * * *